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Study some Physical Properties of Post-Irradiation for Polystyrene Dissolved in Toluene

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Abstract

We have studied in our research the effects of both gamma- rays and time factor on some physics properties as a function of changing some physical properties with the speed of ultrasound for Polystyrene dissolved in the toluene at (30 ± 3°C) temperature by existence the presence of air to maintain the stability of the physics properties of polymeric materials exposed to the radiation.

The samples have been radiated by gamma-ray using irradiated source (Co^{60}) with energy (100 Rad) for (80 minutes) by (8000 Rad) for the prepared samples .Also I has studied the physics properties for all samples, dissolved toluene before and after irradiation directly and after (2, 4 and 6) months for the same prepared and irradiated samples for the different ranges of ultrasound (1250 - 3250) m/s at frequency (30KHz).

Our study showed the properties as density, refractive index, reflectivity, turbidity, absorbance, compressibility, coefficient of fineness, time to relaxation and capacity of relaxation that the values increase with increasing ultrasound and for all samples and for all months while the values of bulk modulus and specific acoustic impedance, and that all the properties that mentioned increase with the increasing speed of ultrasound, except for compressibility and absorption coefficient of the waves of ultrasonic

Also the results showed that irradiation led to improvement values of properties through increase values for properties and the highest values were measured after the irradiation directly, except for compressibility and bulk modulus and the measurements after two months and four months after the irradiation models were also higher than the values of the before irradiation and are mostly comparable with the values measured immediately after irradiation and behavior all these values the same behavior of the polymer, while the values measured at the sixth month was a different and lower values.

1. Introduction

The polystyrene is a polymer glass important industrially and is one of the plastic highly resistant to shocks, chemicals and weather conditions and is characterized by transparent in color and hardness, as well as plastics plasticity of the heat and reach the point of moving glass (100OC) and resists did many of the solvents has many uses such as making plastic porous and is used in industry, household appliances, and bottles of children and in some food containers and other (Li ,Sato and et.al. 2005). And thermal stability, very important to determine the degree of influence in the cells of electrochemical article and thermal stability, good polystyrene (Nasef, Suppiah and et.al. 2004). Showed a lot of research on the effects of high and the task of Polystyrene on different physical properties, morphology, structural changes, which dispel the stages in the mechanical properties (Ramón,2008) the concentration of the piece as well as our study and some researchers, including.

The irradiation leads to the design of different methods, (multiple needs) to get the results used in various applications and in practice there are two ways to irradiation (Adriana, et.al.2007; Nasef, 2001; Nasef, Saidi and et.al 2005) the first is called irradiation partial: the basis is Article polymeric irradiate and add monomers successively gathered recently and the other: irradiation simultaneous: melt the base material (polymer) solvent and then irradiate. The second method was used in this research.

(Adriana, et.al. 2007) Studied the effect of solvent and irradiation by different doses and studied time periods factor (7-14-21-28) days on the crosslink of polystyrene molecules where between that irradiation increased the crosslink of polystyrene molecules dissolved paint and become more consistent solvent and coloring occurs a few changes and fixed in the polymer chain for the methanol solvent and that the values when I said today (28).

While a group of researchers and several research (Li., et.al. 2005,2005, 2006 and 2006) have studied the verification of the formation of polystyrene particles or polystyrene blending with other polymers and modified using a combination gamma rays to fit more applications and better qualities.

And (Nasef, et.al. 2002) studied polystyrene blend with some polymers, where he studied physical and chemical properties immediately after irradiation.

Also (Ramon, et.al. 2008) studied mechanical properties and high impact of the polystyrene basis for the complexes which showed that some properties of the complexes increases with increasing the concentration of polystyrene and some less depending on additives to mix and polystyrene impact is very high on the mechanical properties in terms of tensile strength and durability .

Studied (Emile, et.al. 2006) the installation of mixing water to the expanded polystyrene with other polymers, according to the face of new challenges for water applications as open strongly on the combination of polystyrene .

(Wiesław, et.al.2008) Studied Sulphonation polystyrene expanding its reward and under microwave irradiation with the addition of some materials to the polymer and the processes that sulphonation and irradiation with microwave under the conditions allowed showed the same characteristics of time less than an hour and a half to a quarter of an hour due to irradiation.

In our search we will in the first part the theoretical part, which built properties that were studied, followed by practical part tyro materials used and the method of preparation samples and then method of irradiation used in our research and review of the instrumentation used and the Fleecing of the third is the results and discussed and finally conclusions and sources.

2. The Theoretical Part

Materials consist of overlapped blending two or more wherethe physical or chemical difference between them in the distribution or a specific arrangement. This process of mixing between the materials and different mechanically enable us to obtain new materials with properties differ from the distinct characteristics of each component separately (Schwartz, 1984), and classification of materials according to the composites nature of the components to :

1. Material composites of basis polymer.
2. Material composites of basis ceramic.
3. Material composites of basis metal.

And current research within the first category where the polymers are the best of the basic materials by to its light weight and low cost and ease of manufacture (Belmir,1971) and are classified into several varieties, which concerns us is to(Gorgese,1989):

Polymer plasticity of the heat that contains this product polymers that change attributes the impact of heat is the impact of heat into fuses, when approaching the temperature of the degree of moving glass (Tg) to become flexible, and increase flexibility at the transition to Fuses sticky and when reducing the temperature of molten returns a solid form and strong, for examples of these polymers (polystyrene, polyethylene and poly vinyl chloride).

There are many properties features which show the general behavior of the polymer and we will study some properties of the task so that was measurement mechanical properties of Polystyrene the coefficient of absorption classic (αc) resulting from the viscosity remote temperature and proportional to the square of frequency ultrasound, expressed as a equation (Hassun, 2005; Lamb,2007):

$$\alpha_{c} = \alpha_{vis} + \alpha_{th} \tag{1}$$

Where (αvis)the absorption coefficient resulting from the viscosity. And (α_{th}) resulting absorption coefficient for the passage of ultrasonic waves in the middle.(Al-Ani,2006) absorption coefficient is therefore:

$$\alpha_{c} = \frac{8\pi^{2} f^{2} \eta_{s}}{3\rho V^{3}} + \frac{\delta(\gamma - 1)\omega^{2}}{2\rho C_{v} \gamma V^{3}} \tag{2}$$

(γ) represents the ratio between the specific heat at constant pressure (Cp) and specific heat at constant volume (Cv), (δ) thermal conductivity, (f) frequency ultrasonic waves where $(2\pi f = \omega)$ the angular frequency.

That part of the absorption process converts energy ultrasound waves to heat directly, and in most liquids, the absorption resulting from the heat be a very small amount as they may be neglected for that becoming a previous equation as follows(Lamb,2007; Al-Ani,2006) :

$$\alpha_{c} = \alpha_{vis} = \frac{8\pi^{2} f^{2} \eta_{s}}{3\rho V^{3}} \tag{3}$$

The relaxation time measure of the speed of the wave energy dissipation because the average time required to jump between two identical molecules and the molecule acquires enough energy to overcome the energy barrier for the transfer occurs, so it is given to the equation (Al-Bermany, 2010) :

$$\mathrm{t} = \frac{4\eta_{s}}{3\rho \mathrm{V}^{2}} \tag{4}$$

$$D = \alpha / f^{2} \tag{5}$$

Where (D) capacity of ultrasonic wave after the relaxation process and given the reluctance to voice (Lamb,2007; Al-Ani,2006; Al-Bermany, 2010) :

$$\mathrm{z} = \rho \mathrm{V} \tag{6}$$

It is the Laplace equation can be calculated compressibility (Al-Ani, 2006; Al-Bermany, 2010):

$$\mathrm{B} = (\rho \mathrm{V}^{2})^{-1} \tag{7}$$

Inverted and compressibility factor gives us flexibility, as shown the following equation (Lamb, 2007):

$$\mathrm{k} = \mathrm{B}^{-1} = \rho \mathrm{V}^{2} \tag{8}$$

Material cause absorption of radiation fallen active electronically may lead to the disintegration of fractions if the value of energy absorbed is greater than the value of the disintegration of one of the links or move to a higher energy level as the probability of absorption increases with increasing concentration of the substance in the low energy level and increase the number of phonons light beam. The appropriate use of the equation for the Lambert - Beer in different spectral ranges and required to be a light user monochromatic (Danial,2007) :

$$A = -\alpha_{op} C_{m} L \tag{9}$$

The absorption coefficient (α) was calculated from Beer–Lambert law equation (Ingle,1988):

$$A/A_{o} = e^{(-\alpha x)} \tag{10}$$

Where (A_o) is the initially amplitude of the ultrasonic waves, (A) is the wave amplitude after absorption, the transmittance (T) is the fraction of incident wave at a specified wavelength that passes through a sample was calculated from the following (equation (Dipak,2001):

$$T = I / I_o \tag{11}$$

Known refractive index, gives the following formula:

$$n = \frac{c}{v} \tag{12}$$

Where (c) the speed of light, (v) to the speed of light in the center of a given. And given the value of the reflectivity (R) for the fall when the vertical angle of incidence equation (Grant, 2008; Al-Bermany,2009):

$$R = \left[\frac{n - 1}{n + 1} \right]^2 \tag{13}$$

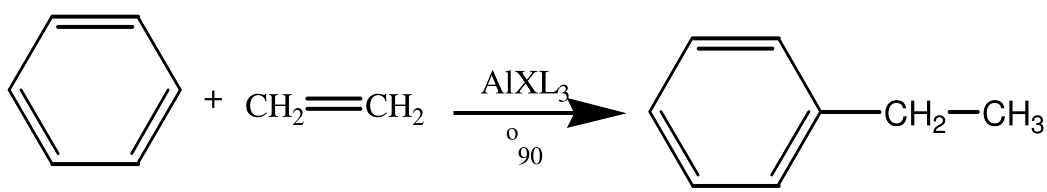
Measured coefficient of fineness from the equation is define as a measure of the severity of interference fringes (Grant, 2008; Al-Bermany,2009):

$$F = \frac{4R}{(1 - R)^2} \tag{14}$$

2. Experimental Part

2.1. The Used Materials

Polystyrene: A polymer glass is important industrially and is one of the plastics plasticity of the temperature of the degree of moving glass (100°C) is resistant to do a lot of chemicals as acid and the other basal and dissolves in many solvents and has a lot of uses plastic as an industry for domestic purposes and the plastics industry porous hard ((Li, Sato and et.al. 2005; Nasef, Suppiah and et.al.2004). Attend the polystyrene from styrene and this prepared from ethylene and benzene and so be passed in the ethylene gas under pressure and the presence of aluminum chloride as a catalyst as in below :



Toluene: The scientific name by the IUPAC is methyl benzene (Methylbenzene). Toluene is a colorless liquid belonging to the gasoline, also called Almthele gasoline. Toluene belongs to a group of compounds called aromatic hydrocarbons and chemical formula C6H5CH3. Toluene molecule contains six carbon atoms arranged in a ring with five atoms of hydrogen and methyl group (CH3), and makes the processing of oil or toluene distillation of coal tar. Chemist's toluene is used as a raw material for the production of other chemicals. Understand, for example, benzoic acid, making it sometimes. It uses a preservative benzoic acid in food, beverages, cosmetics and other("Pure Component Database,2007).

2.2. Preparation of Sample

- **Preparation solution:** attend the solution dissolves polystyrene irradiated with weights specified in the solvent coloring where urbanization has been mixing polystyrene irradiated with solvent at a temperature of(100°C)using the mixer type (Magnetic stirrer).

- **Irradiation process:** the use of radioactive source (Co^{60}) to get the rate of radiation hanging by Gamma (100Rad/min) of card (1.25MeV) on the polymer for a period of time (80min), any dose of radiation (8000rad).
- **Preparation of sample:** attended different weights of the polymer (1-10) gm for all measurements of physical properties of dissolving these weights in (25ml) were obtained by solvent (1-10) gm/ml at temperatures (30 ± 3 ºC).

2.3. Measurements

Measurements were taken of all samples, and after irradiation and taking measurements of specific intervals after. The first irradiation immediately after dose, the second dose two months for the same samples and then the third measurement after four months. Finely the last measurement was after six months. And we used:

- Used the density measuring capacity (25) ml to measured **density**.
- Used of a device (**spectrophotometer**) the type of plant to measure the absorbance by the (GBC Scientific Equipment) German origin. Where the wavelength range in which it operates between the (200-1200) nm to measured **absorbance**.
- Used of a device type (**ZEISS 13743**) German origin to measure the refractive index, which measures the refractive index of solutions for the values ranged between (1.71-1.30) to measured **refractive index**.
- Using **turbidity** meter is manufactured by a company (Hach Chemical Company) to measure the **turbidity** model (2100A) of U.S.A. origin to measured **Turbidity**.
- **Mechanical properties** measurements by pulse technique of sender-receiver type (SV-DH-7A/SVX-7 velocity of sound instrument) frequency (30 KHz).

3. Results and Discussion

The results that obtained show that most of the physical properties affected by the increase of the speed of ultrasound and most results have improved and took the values of higher than normal when exposed to radiation and it showed a change continuously in their physical properties over time, especially after six months the results were different from the behavior that taken by the rest of the results, as well as the behavior of polymer**.**

(Figure 1) Shows the intensity values is increasing with increase values of the speed of ultrasound, as increasing concentration of the substance in the solution leads to the coherence of the material and configuration correlation complex between molecules of polymer and solvent, which led to the formation of large molecules that work on the transfer of mechanical waves from a source of disorder on the form of band positive and thus to increase the speed unlike liquids simple and pure and that leads to the motion of the particles be less due to collisions and also note that the process of irradiation led to an increase of all values, this indicates the process of irradiation resulted in the first stage of the degradation of chains polymer and the generation of free radicals that crosslink with the polymer chains with each other and increase the mass per unit volume and this agreed with (Al-Bermany, 2009 and 2010). Result shows that the highest values are directly after irradiation, and the values at the second and the fourth month higher than the value before irradiation. The values of the sixth month was less than all the values, because of the time period, which led for the degradation in band which bind atoms and molecules and thus break the polymer chain because of this degradation and this underscores polymers irradiated appear change continuous in behavior and properties after a period of time that similar to what happened to (Adriana, et.al. 2007) when studying the impact of irradiation on polystyrene and the effect of time on the properties and less value at today (28).

(Figure 2) Shows the values of the refractive index, which increased values with increasing values of the speed of ultrasound and also with irradiation because increased polymer particles dissolved in solution and the process of crosslink that obtained as a result of irradiation, where led to increased susceptibility to reverse some the lengths of positive rays falling and thereby increase the

refractive index, while the values of the sixth month is the only one that is less values and behave differently of the nature of the polymer because of degradation of the crosslink that distanced between molecules and increased spaces between the particles and thus the amount of light pass between them.

As (Figure 3) shows the reflectivity calculated from equation (11) where we note the increasing values of reflectivity and all the results with increasing the speed of ultrasound is attributed to the increased concentration lead to increased density of polymer as well as to crosslink led to a convergence of chains thus increased its amount of radiation reflected from polymer and solvent molecules are larger, as well as with irradiation, except for results at the sixth month of this pick in the applications so that it is a good reflector to the sun when used in the outer layers of materials.

The results of turbidity shown in(Figure 4) for different concentration where we note increased with increasing speed and the reason for this is due to increased polymer particles in the solution on the other hand that the polymer particles become interaction with the solutions that formed the complex composite and are stuck in the solution and irradiation led to a break ties vulnerable as interacting groups of the unsaturated double bonds with hydrogen atoms made up the roots of polymeric able with other union and the formation process of the complexity of the polymer chains, which led to an increased susceptibility to complex fractions disturbing the solution, here also the results of the sixth month is in deferent of the other values.

Were measured absorbance in practice and for all concentrations showed in the (Figure 5) that increasing absorbance commensurate with the increase in the values of speed of ultrasound as a result of increasing the number of atoms of the increased in concentration, leading to increased absorption of atoms and the reason for this is due to the greater increase concentration of growing atoms and molecules of the substance in solution, and both of which contribute to absorb part of the ray carried out to the solution and the absorbance increases upwards and this is also confirmed by the equation (9) that concentration directly proportional to the absorption material and this is one of the basics according to the law of Lambert Beer. We also note from the figure that the values of the results of six month in some increasing and others decreasing, and the reason is that the kinetic energy of the polymer particles and increase the irritation of electrons in the levels and then decrease the number of electrons stable as a result of different temperatures, which are responsible for the absorption photons incident light (Yong ,2007; wang,et.al.2007).

Calculated absorption coefficient for ultrasound waves of the difference values in values waves on the screen oscilloscope and shown in(Figure 6) and the application of the equation number (11) and measured values of the practical results through the waves in the screen oscilloscope. The results showed the partially that the values decrease with the increase in ultrasound and attest to this equation (11), the absorption coefficient is proportion inversely with both the speed and intensity that any absorption coefficient decreases with increasing the speed of ultrasonic waves.

Coefficient of finess calculated from the equation (14) and the result shown in (Figure 7) where we note an increase values because the coefficient of finess depends mainly on the amount of radiation reflected in this research note that the mixture solvent and polymer that reflects the light beam are good and even the values at the sixth month is also increased but lower values that result to lift some of the links between molecules and polymer chains.

Values of compressibility calculated from the equation (7) and (Figure 8) showing a decrease of the values of compressibility with the speed of the waves of ultrasound, and the reason for this is due to the convergence of molecules which in turn led to the gathering chains polymeric converged with each other as a result of the integration of two types of molecules and therefore a result of the crosslink of the polymer chains, which makes them take up less space in the solution and thus take less space. This is consistent with (Al-Amiri, 2003).

The time relaxation values calculated of by the equation (6) and (Figure 9) shows the equation between the time of relaxation with speed of the waves of ultrasound, noting the increased time to relaxation with the speed of the waves of ultrasound as a result of the complexity of strings polymeric with each leading to increased internal friction between the layers of liquid resulting to compress and

rarity is a result of the effect of ultrasound, thus increasing the time required to re-excited molecule to its original position.

Calculated values of bulk modulus for various concentrations and (Figure 10) that shows the increase in the values of bulk modulus with the speed of the waves of ultrasound, according to the equation (8) notes the adoption of bulk modulus on the speed of ultrasound in the President so it's expected behavior of bulk modulus the same behavior of the speed of ultrasound in terms of increase and that a few intensity values shall be almost non-existent and depended on the effect speed only.

(Figure 11) Shows the increase in the values of specific acoustic impedance with increase the speed of ultrasound, and the reason for this is due to the increase in the number of molecules in solution which leads to increased intensity of the center carrier and thus increase the speed of ultrasound, because the speed increase significantly with increasing concentration, leading to increased specific acoustic impedance, This show in equation (6) .

(Figure 12) shows the equation between the relaxation amplitude and increase the speed of ultrasound, as seen from the figure that the relaxation amplitude increases with the speed of the waves of ultrasound and the reason is due to the large distance traveled by the molecule during the process of arousal, because the moment of inertia of the partial large to be biggest (Norbet, 2005) and the irradiation leads to hardening the bonds of the polymer and increase the bear and this increases the moment of inertia of the partial values and thus increase relaxation amplitude. relaxation amplitude are proportional directly with the absorption coefficient in the equation (5) .

Figure 1: The relationship between speed of ultrasound waves and density

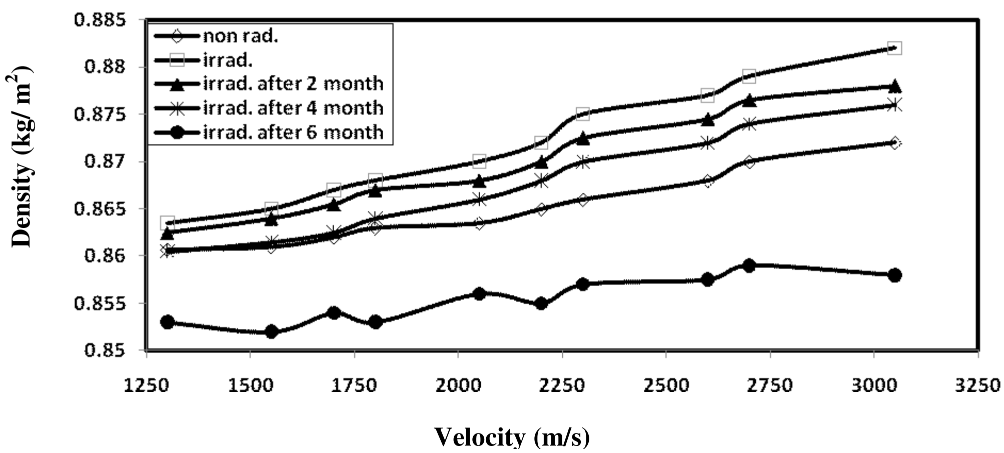


Figure 2: The relationship between speed of ultrasound waves and the refractive index

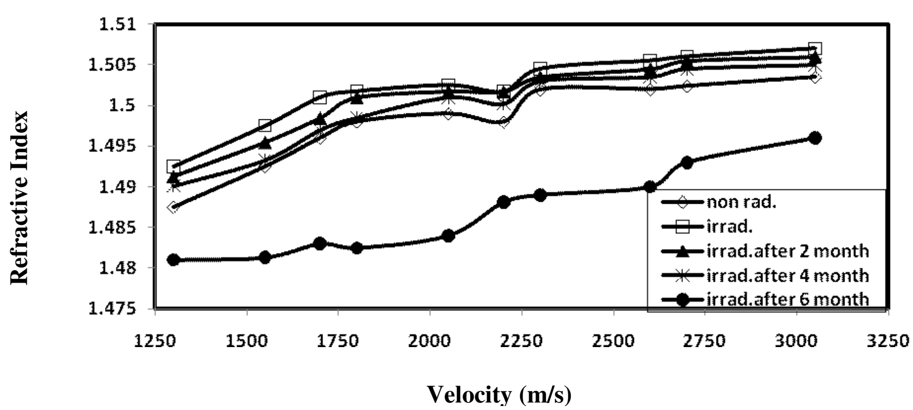


Figure 3: The relationship between speed of ultrasound waves and reflectance

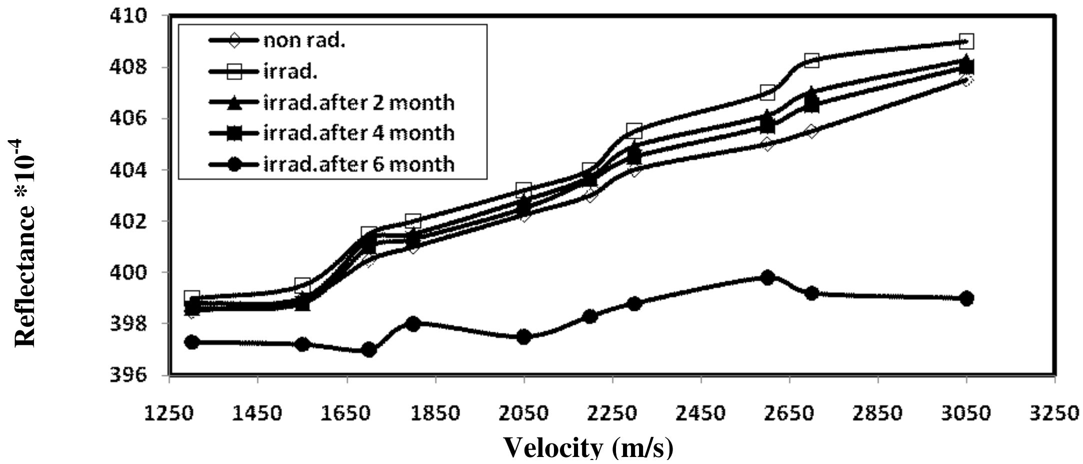


Figure 4: The relationship between speed of ultrasound waves and turbidity

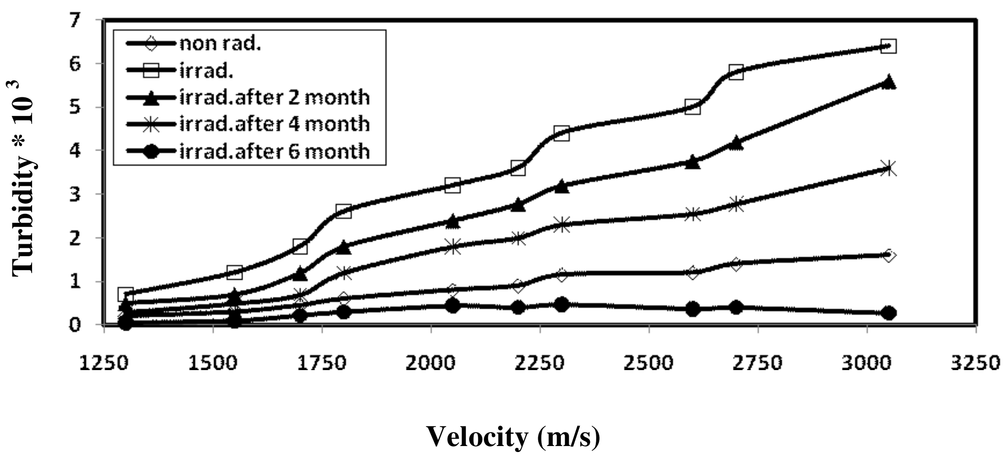


Figure 5: The relationship between speed of ultrasound waves and the absorbance

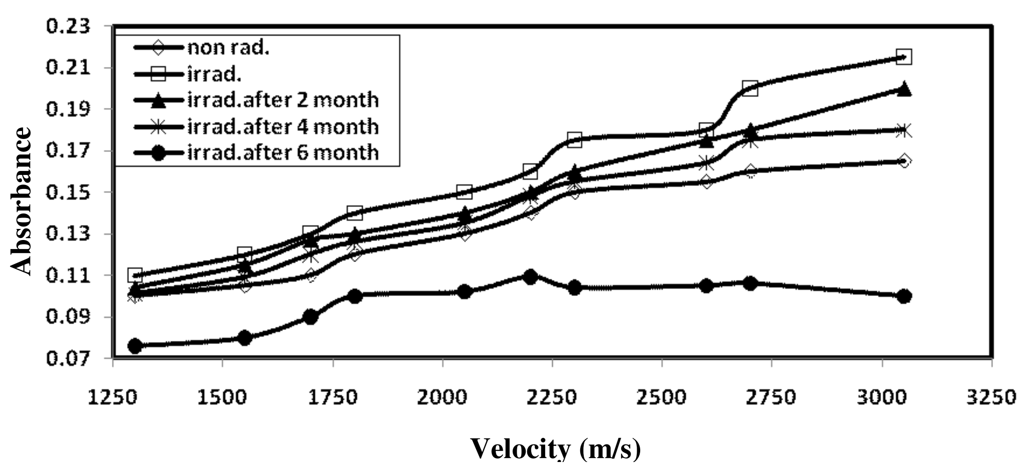


Figure 6: The relationship between speed of ultrasound waves and the absorption coefficient of ultrasonic waves

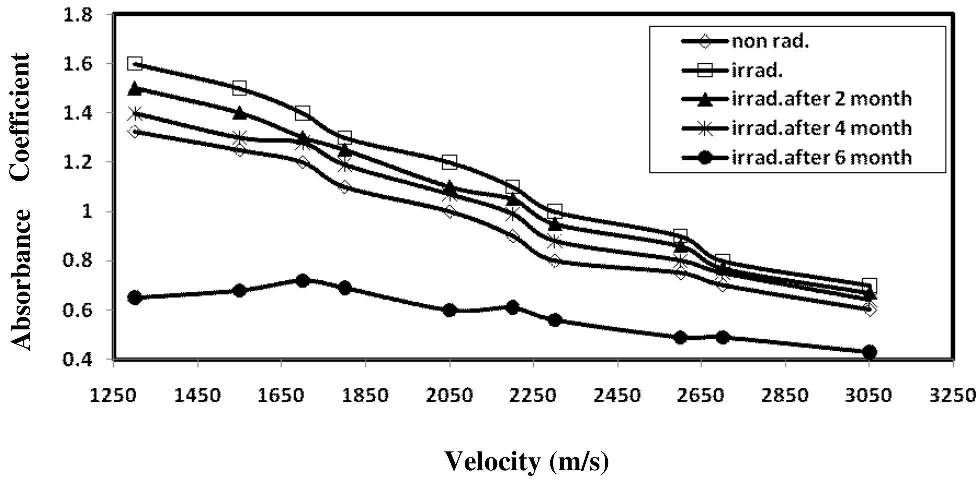


Figure 7: The relationship between speed of ultrasound waves and coefficient of finess

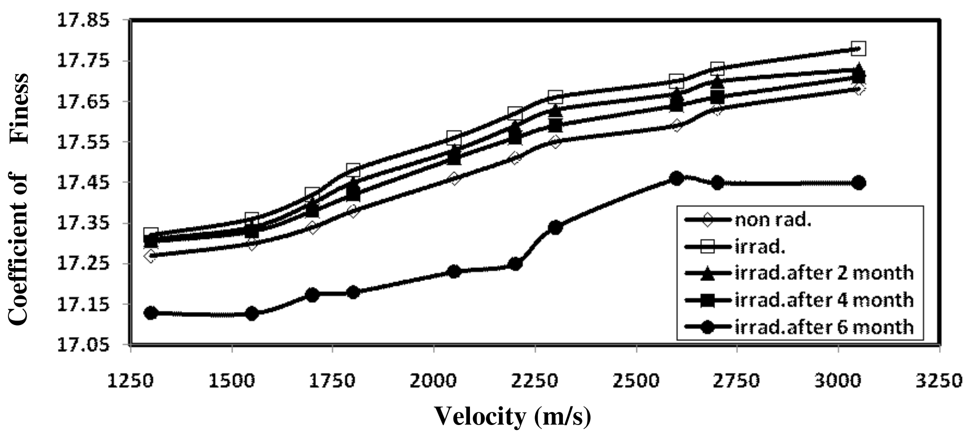


Figure 8: The relationship between speed of ultrasound waves and compressibility

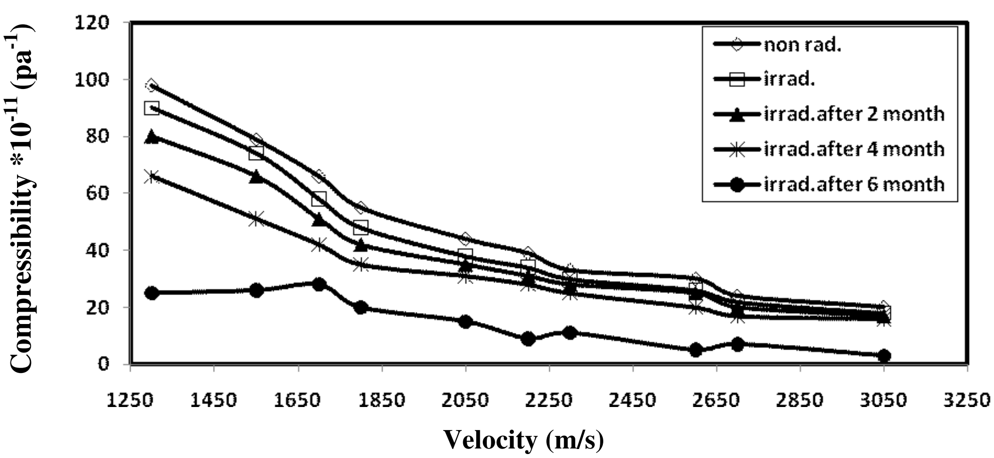


Figure 9: The relationship between speed of ultrasound waves and relaxation time

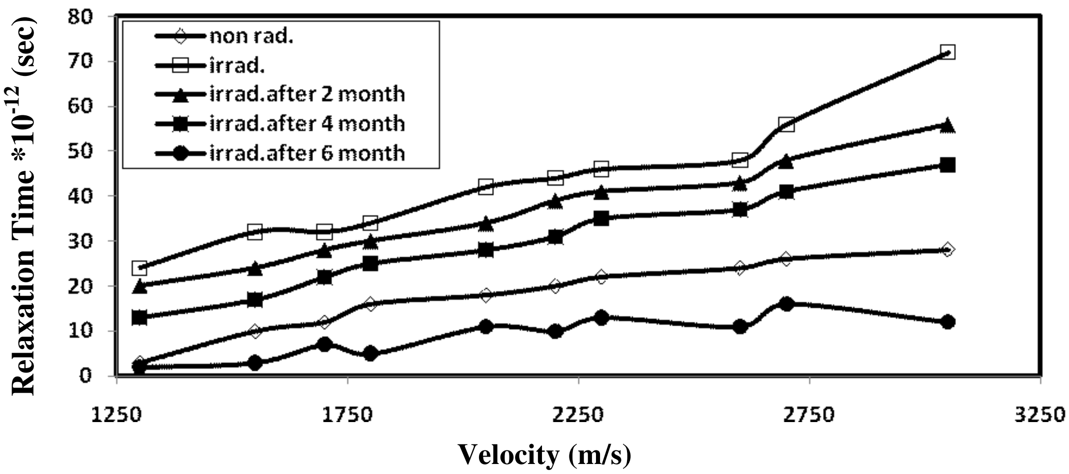


Figure 10: The relationship between speed of ultrasound waves and bulk modulus

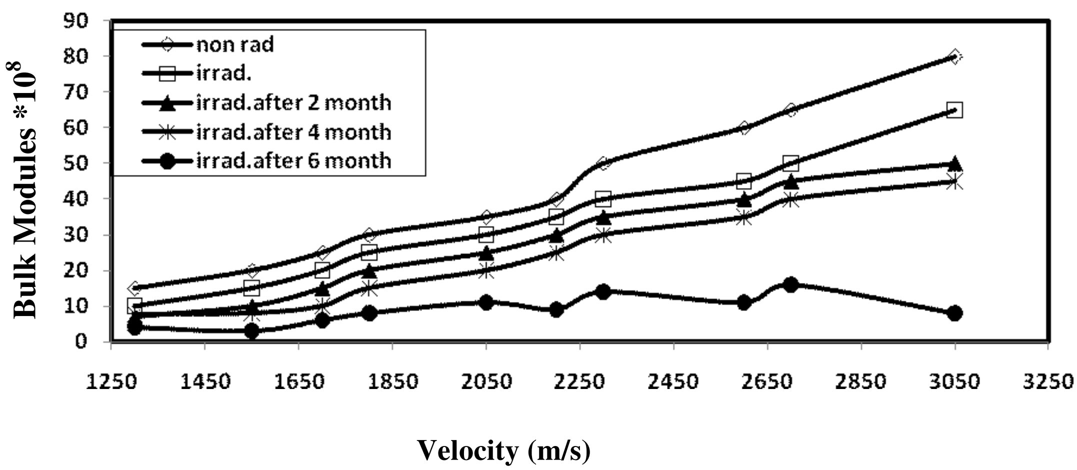


Figure 11: Shows the relationship between speed of ultrasound waves and specific acoustic impedance

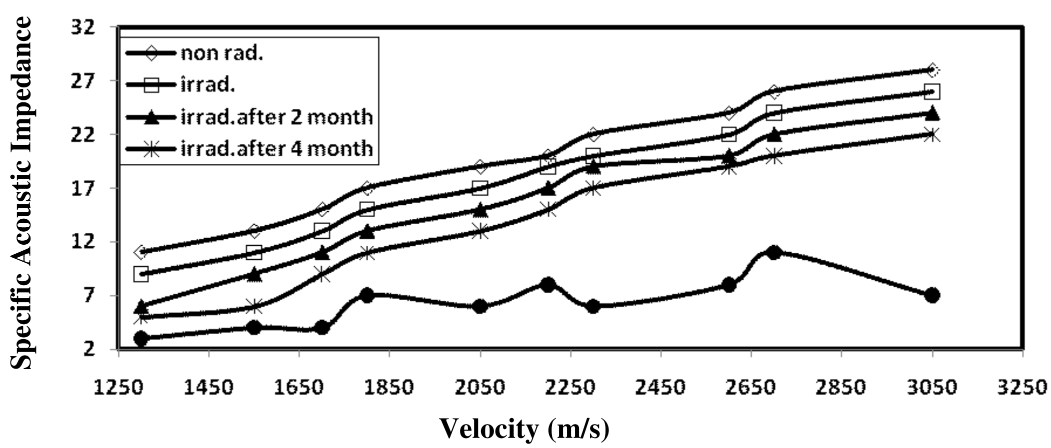
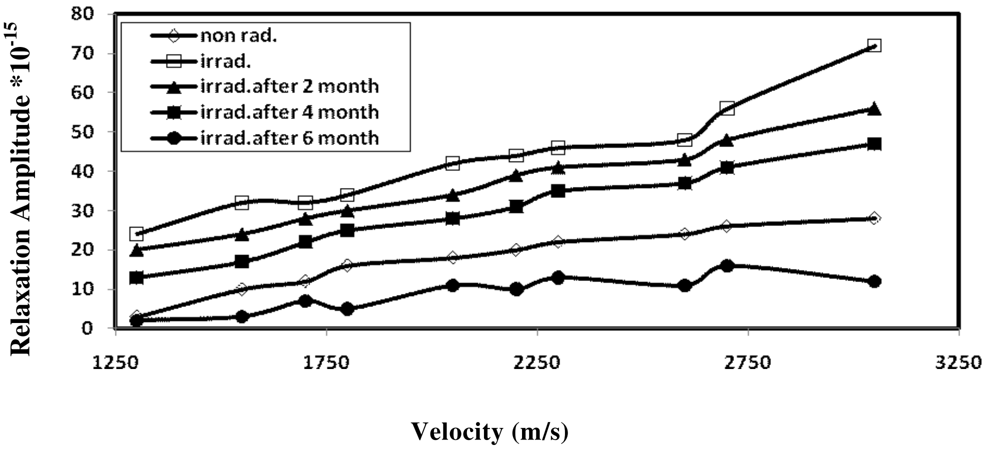


Figure 12: The relationship between speed of ultrasound waves and relaxation amplitude



4. Conclusions

1. The irradiated polymer shows a change continuing their properties with the period of time.
2. The gamma-ray improves and changes some properties of ps-toluene composite and *depending* on the nature of radiation and irradiation conditions and the value of radiation dose and the type of polymer.
3. Physics properties improved for ps in our present, where the irradiation to strengthen the polymer against external influences by tempering the bonds except the results at the sixth month.
4. Could use nuclear energy for the different properties of polymers.
5. Occurrence of the phenomenon of entanglement after irradiation and remained such circumstances until the fourth month, while got the degradation of the entanglements at the sixth month.
6. Our study shows that it would prefer not to use this ps-toluene composite irradiated after six months on the irradiated as a result of changing the behavior of most of the properties in addition to the degradation of most of the linkages between the polymer chains when the passage of this time period.

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